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Eric Van Ranst
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APPLICATION OF X-RAY TOMOGRAPHY FOR QUANTIFICATION OF THE SOIL PORE STRUCTURE AND VISUALIZATION OF SOIL ORGANIC MATTER

L. Bouckaert^{*}, D. Van Loo, S. Sleutel, S. De Neve, P. Jacobs and L. Van Hoorebeke

Department of Soil Management and Soil Care, Ghent University

^{}Corresponding author: Liesbeth.Bouckaert@ugent.be*

Soil organic matter (SOM) determines soil fertility and soil quality and plays an important role in the global carbon cycle. Therefore, a better understanding of the mechanisms involved in the protection of SOM will be of utmost importance in predicting the evolution of soil quality and the impact of SOM on global change. Hypotheses to explain the protection of SOM against microbial degradation include chemical recalcitrance and physical protection of OM. Recent advances have stressed the importance of soil structure as a factor in SOM dynamics. To further our understanding in the complex interaction between SOM and the soil matrix, many studies have attempted to tackle this complexity by using measurements of soil aggregates as surrogates of the soil structure. However, narrowing soil structure down to soil aggregation is a gross oversimplification. In reality, the undisturbed soil profile exists as a continuous convoluted pore, bounded by solids and not as a bed of aggregates.

The application of X-ray computed tomography (CT), a technique that generates cross-sectional images of an object by computer software from multiple X-ray scans, enables the visualization of the soil pore space in three dimensions. The very few studies applying CT scanning in soil science have attained spatial resolutions of several μm . The UGent centre for X-ray Tomography (UGCT) has developed a CT scanner which is capable of providing the highest spatial resolutions in CT scans attainable at the present, i.e. about 1 μm and is developing a new nano-CT scanner with a spatial resolution of 0.4 μm . Application of this equipment for visualization of the soil structure will provide unique data on the 3D soil pore distribution which could enable us to relate the soil structure to SOM dynamics. The objective of this research is to investigate the potential of X-ray CT for the visualization of the pore space and ultimately the automated visualization of SOM. First results from ongoing experiments involving the 3D visualization of pore space on different scales and the visualization of OM coatings will be presented.

P-FORMS AND THEIR BEHAVIOUR IN FLEMISH SOILS

S. De Bolle^{*}, J. Salomez, S. De Neve and G. Hofman

Department of Soil Management, Ghent University

^{}Corresponding author: Sara.DeBolle@UGent.be*

Introduction

In recent decades, the enrichment of European waters with anthropogenic sources of nutrients (nitrogen and phosphorus), and hence eutrophication has become a major environmental issue. Contrary to nitrogen (N), less is known about phosphorus (P) losses.

Phosphorus losses occur via two pathways, i.e. through erosion (runoff) and through leaching. Whereas P losses via erosion have been extensively studied, less is known about P leaching. As Flanders has a lot of soils which are phosphate saturated or prone to saturation (phosphate critical), ways must be sought to decrease the phosphate levels in these soils in an economically responsible way. Furthermore, it is important to achieve the standards of (future) European and regional legislation in terms of phosphorus.

Methods

To get acquainted with the behaviour of P in soils, insight must be gained into the P-forms and their amount present and into mutual relationships between these forms. As a first step, two fractionation techniques, i.e. the fractionation by Williams and the fractionation by Hedley, are performed on soils with a range in phosphate saturation levels.

The next step will be to investigate the adsorption/desorption pathways of these soils and to set up adsorption/desorption curve. Correlations between P forms and amount and the adsorption/desorption pathways will be worked out.

Within the framework of decreasing the P status it is necessary to almost entirely stop giving P fertilizer. In this respect following questions need to be considered: will the P availability (also on soils with high P levels) be high enough to maintain the good yields? Which enzymes are dominant for each kind of saturation level? What is the effect of phosphate solubilizing bacteria or some mycorrhiza on the P level in soils? Is there a co-effect or do they work against each other?

First of all we will investigate the effect soil microbiota have on the P levels in the soil by putting up incubation experiments whereby soil is enriched with: only bacteria; only mycorrhiza or taken a mixture of both bacteria and mycorrhiza. In a later stage it could be interesting to investigate the difference in P uptake and in microbiota between fields which are fertilized and fields which are not fertilized for years.

Expectations

The primary goal of this research is to find out whether some P-forms are abundant with a certain level of phosphate saturation and whether shifts from one form to another occur. The first conclusions are that in sandy soils with a phosphate saturation level of 50% following P-forms are abundant, P which is easy soluble and P which is bounded on Al and Fe.

The next goal is to detect whether these P forms are prone to leaching or not. When there is a relationship between different P forms and the adsorption/desorption capacity of the soil we could tackle the P saturation in different ways for different kind of soils. It could also show whether it's